ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 2| February 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2023: 8.224 || ISI Value: 1.188

ASSESSMENT MONITORING OF LAND USE AND LAND COVER CHANGES ANALYSIS USING REMOTE SENSING AND GIS TECHNIQUES - A CASE STUDY OF REDANG ISLAND, TERENGGANU, MALAYSIA

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ABSTRACT

One of the factors behind global environmental change is land use and land cover modifications. The changes in the earth's surface can provide valuable insights into the interaction between the natural environment and human activities. This study was conducted to analyze Landsat satellite data to map the surface characteristics of the area and analyze land use pattern and land cover (LULC) changes in Redang Island, Terengganu. The remote sensing and GIS method is used as the key application by researchers to analyse the extent of changes in land use that occur. Researchers are also using the supervised application process to classify the form of land change in the study area based on the selected Landsat picture. Review of changes in land use in the study area between 2000 and 2020. The outcomes of the current research indicate that the location of the water land use study always dominates for the selected year's study and in 2020 recorded land use for the water of 8071.98 hectares (72%), forest land use recorded of 1781.80 hectares (16%), clouds of 395.30 hectares (4%), and built up 922.20 hectares (8%).

KEYWORDS : ***Land use change, Redang Island, Remote Sensing, GIS***

INTRODUCTION

The concept of land use is the action of humans on land, while land cover refers to the external environment of the surface of the earth (Meyer & Turner 1994). There has been pressure on land use/land cover (LULC) and environmental damage due to the rising human population and socio-economic needs (Holdgate, 1993). LULC changes occur due to ineffective governance of planning agricultural land, cities, forest areas and water are therefore causing negative effects on the environment, such as landslides, floods, and so on. (Seto et al. 2002; Prakasam 2010). Anthropogenic activity, rapid urbanisation and deforestation are starting to cause LULC changes (Li et al. 2018). The urbanisation process has also led to the loss of agricultural land, the destruction of flora and fauna habitats (Lopez, Bocco, Mendoza, & Duhau, 2001; Alphan, 2003). Moreover, according to (Sun et al., 2008) stated that changes in LULC will also impact on the quantity of water and the relationship of water supply and demand. Thus, The environment will be affected by excessive exploitation and unsystematic management of natural resources.

Remote Sensing and Geographic Information Systems (GIS) can assist in obtaining information related to the spatial distribution of land use and land cover (LULC) accurately and quickly in an area (Carlson & Azofeifa 1999; Dezso et al. 2005; Guerschman et al. 2003; Rogana & Chen 2004). GIS software also plays a role in helping to collect, store, display, and analyze the digital data needed for LULC change detection (Demers 2005; Wu et al. 2006). While image through remote sensing is essential information for the GIS analysis process. By using satellite images to obtain synoptic data of the earth's surface (Ulbricht & Heckendorf 1998). Landsat Data Multispectrum Scanner (MSS), Thematic Mapping (TM), Enhanced Additional Thematic Mapping (ETM +), and the latest Land Imaging Operations (OLI) have been widely used in land cover studies since the inception of the Landsat program in 1972, especially in agricultural areas and forests (Campbell, 2007). The large data archive and the suitability of the Landsat satellite image spectrum resolution are important reasons for the use of such data. In this study Landsat 4-5 TM C1 Level-1 and Landsat 8 OLI / TIRS C1 Level-1 were used to take images for the years 2000 to 2020.

Malaysia is famous with beautiful and peaceful island. Since 1985, 42 islands have been gazetted as Marine Parks in Malaysia to protect and conserve various aquatic habitats and marine life (Department of Marine Malaysia, 2014). The status of the marine park as a tourist destination has increased the arrival of tourists.

This study aims to analyze Landsat satellite data to identify the surface area and evaluate the pattern of land use change and land cover (LULC) in Redang Island, Terengganu Malaysia. Four Landsat images covering the entire Redang Island captured by Landsat 4-5 TM and Landsat 8 OLI / TIRS C1 Level-1 were used. These images have been processed in advance and classified into four things namely built up, clouds, forest, and water. Each of the data analyzed can assess

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the level of changes in land use patterns from 2000 to 2020 from four different perspectives. The results of this study will help stakeholders in formulating strategies for land use in the Redang Island more prudently and efficiently. This LULC change data is also an important indicator of environmental management and future planning (Fan et al. 2007; Prenzel 2004). The results of this study are also expected to contribute and assist in future tourism and physical development activities in the Redang Island.

RESEARCH OBJECTIVES

The purpose of this research is to analyze the LULC changes in the Redang Island, Terengganu Malaysia through using GIS technologies and data from remote sensing. In order to attain the objective, the following specific goals are pursued;

• To dentify the Redang Island LULC changes based on satellite images from the years 2000, 2009, 2015 and 2020 using remote sensing and GIS software.
• To analyze the patterns and trends of LULC changes in Redang Island for year 2000, 2009, 2015 and 2020 through GIS analysis.

STUDY AREA

Redang Island (5 ° 46′30 ″ N 103 ° 0′54 ″ E) is an island in the Terengganu District of Kuala Nerus, Malaysia. It is one of the largest Island off Peninsular Malaysia east coast. Its clear waters and beautiful beaches make it very famous. It is one of nine Island that form a marine sanctuary park, providing visitors with opportunities for snorkelling and diving (Wikipedia Contributors, 2021). The island is a breeding site for turtles, and these turtles serve as an ecotourism draw.

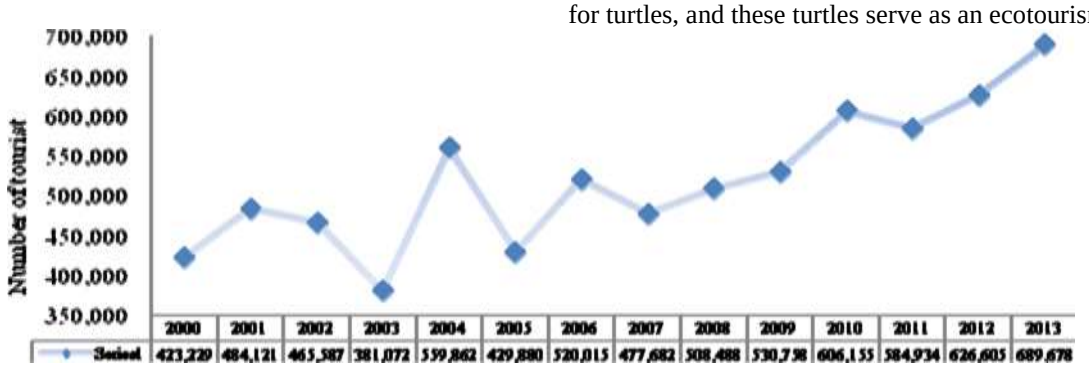

Figure 1: Number of tourists to the Marine Park in Peninsular Malaysia from 2000 to 2013
Source: (Department of Marine Malaysia, 2014)

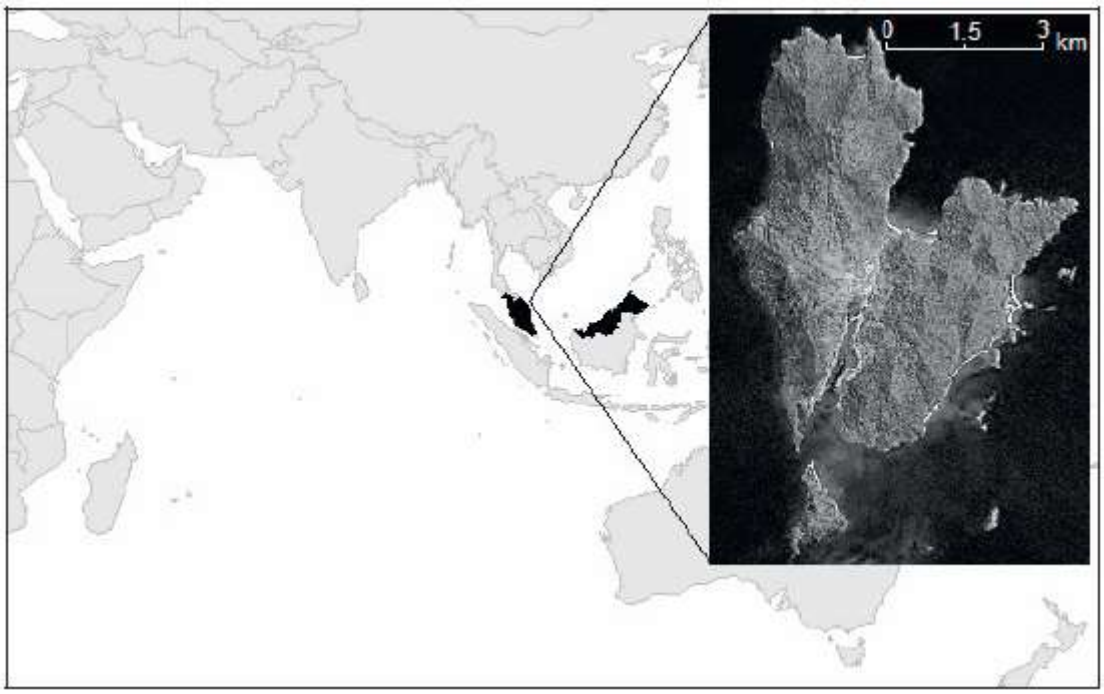

Figure 2: Redang Island
Source: (Fisher et al., 2008)

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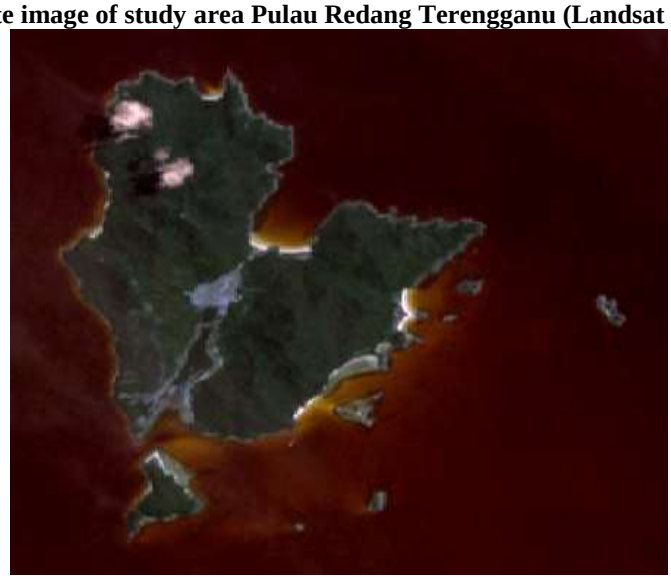
METHODOLOGY

Satellite Image Data (Landsat)

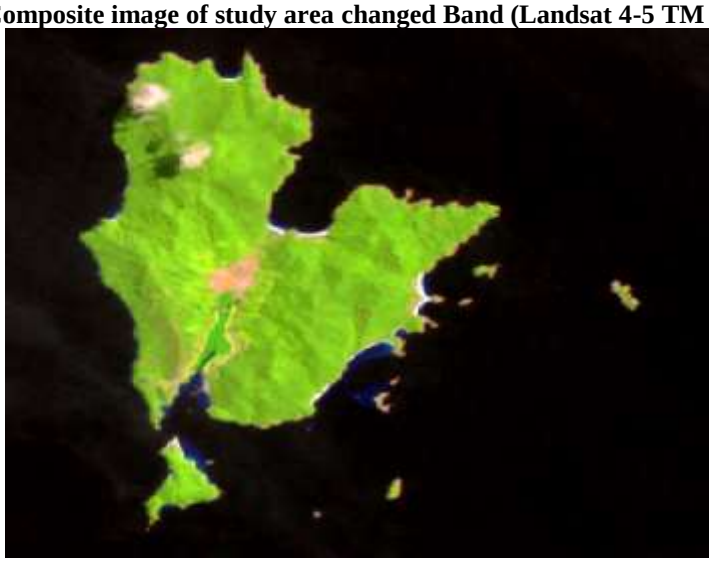
Landsat data is one of the most frequently used programs in analyzing the image of the earth since the year it was introduced in 1972 (Campbell, J, 2007). Land satellites are widely used in various applications such as agriculture, land use, environment, water, development, transportation, and so on (Ulbricht, KA, & Heckendorff, W. D, 1998). This program is one of the programs provided openly and can be accessed by anyone by downloading the satellite image through the website *United States Geological Survey* (https://earthexplorer.usgs.gov/). In this study, the images selected through the website have some criteria that are emphasized as the satellite image must have less than 10 percent (%) cloud coverage or no cloud coverage that will interfere with the clarity of the image. Among the Landsat images that have been selected are 2000, 2009, 2015, and 2020. There are several colors used to produce thematic maps based on Band such as red for Band 5, green for Band 4, and blue for Band 3. The colors can be selected and determined by the researcher to help in processing the images.

Figure 3: Composite image of study area Pulau Redang Terengganu (Landsat 4-5 TM C1 Level-1)



(Source: https://earthexplorer.usgs.gov/)

Figure 4: Composite image of study area changed Band (Landsat 4-5 TM C1 Level-1)



(Source: https://earthexplorer.usgs.gov/)

Table 1: Satellite Images used in the study

YEAR	Landsat type
2000	Landsat 4-5 TM C1 Level-1
2009	Landsat 4-5 TM C1 Level-1
2015	Landsat 8 OLI / TIRS C1 Level-1
2020	Landsat 8 OLI / TIRS C1 Level-1

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Image Pre-processing

Downloaded satellite data needs to go through several pre-processing processes such as a geometric correction to improve distortion, geometric projection transformation from projection WGS1984 to MRSO 2000, and conversion of pixel value from digital number (DN) to surface reflection value (Choy, LK, & Noor, NNH M, 2018). After the pre-processing steps are done, the clipping process will be performed. Images downloaded from the USGS will usually cover a very wide area that covers the sea area and the overall image of the Terengganu state area. The next step is the zoom in and zooms out process carried out using ArcGIS software. This process aims to get a clearer image and reduce the oversize of data.

Landsat Classification and Accuracy Assessment

The classification of images has been made using satellite images is to identify the types of land use and land cover. Each image classification that has been generated will be grouped by class to generate a thematic image classification. The selected location will be determined by the classification of land use type and land cover by using polygons. Image classification using supervised data classification method or supervised data classification. The researcher decides the supervised data, such as the identification of sea areas, forest areas, etc.

Land Use Changes

Land use changes in the area are carried out by comparing the study location by year through ArcGIS 10.3 software.

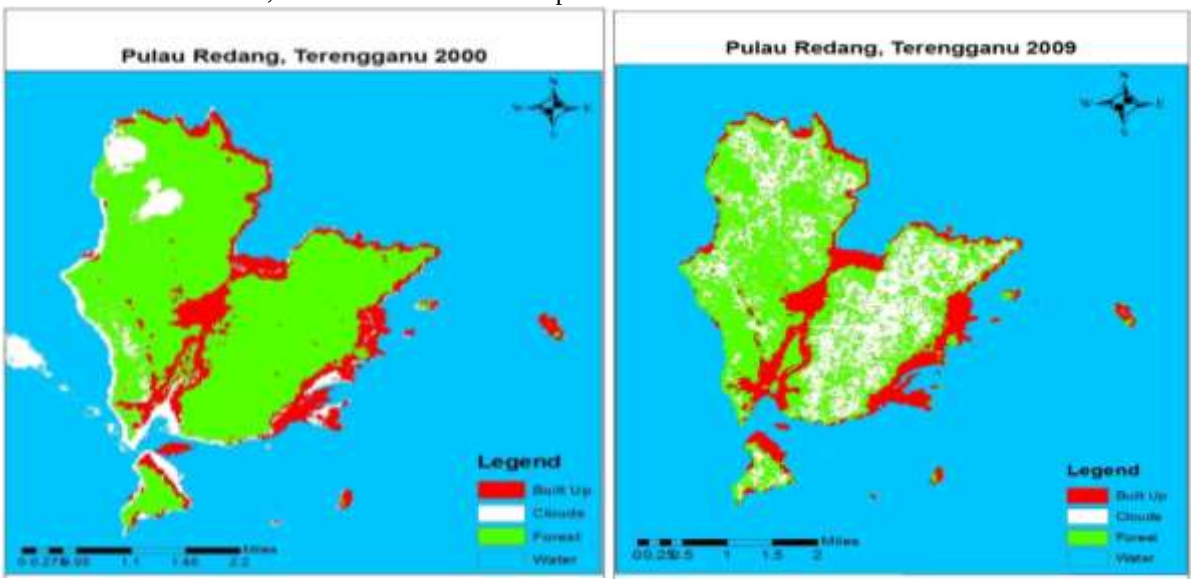
Table 2: Classification of Land Use and Land Coverage

Land Use and Land Cover Class	Description
Built Up	Housing, commercial stores, industrial and light industry stores, services, transportation
Clouds	Clouds
Forest	Mixed forest
Water	Seawater

RESULTS AND DISCUSSION

Redang Island land use changes in 2000, 2009, 2015, and 2020

Significant changes can be seen in the land use of Redang Island, Terengganu. Figure 5 shows the land use in Redang Island in the year specified. Table 3 shows that in 2000, land use of water dominated Redang Island which was 74% which is equivalent to 8184.61 hectares, and land use for built up recorded as much as 4% which is equivalent to 491.44 hectares. Meanwhile, in 2009 the land use has increased by 4% which makes the land use of water in 2009 in Redang Island is 9821.05 hectares (78%). While the lowest land use in 2009 was built up which recorded 500.68 hectares (4%). Land use of water is increasing probably due to erosion which causes the area of seawater to increase.



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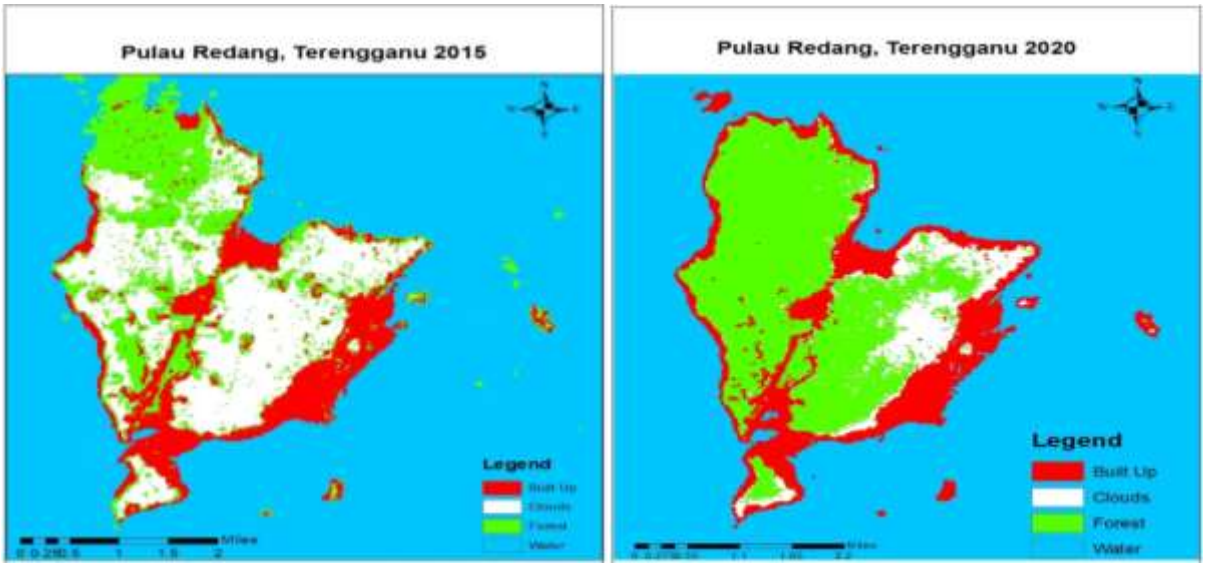

Figure 5: Land use changes in Redang Island in 2000, 2009, 2015, and 2020.

Class	Sum of Area (ha), (2000)	Percentage (%)
Built Up	491.4439504	4
Clouds	342.399062	3
Forest	2038.043037	18
Water	8184.613951	74
Grand Total	**11056.5**	**100%**
Class	**Sum of Area (ha), (2009)**	**Percentage (%)**
Built Up	500.669926	4
Clouds	761.9329269	6
Forest	1468.559981	12
Water	9821.047166	78
Grand Total	**12552.21**	**100%**
Class	**Sum of Area (ha), (2015)**	**Percentage (%)**
Built Up	790.8655247	7
Clouds	1394.357028	13
Forest	1006.825674	9
Water	7513.451773	70
Grand Total	**10705.5**	**100%**
Class	**Sum of Area (ha), (2020)**	**Percentage (%)**
Built Up	922.1829372	8
Clouds	395.2859012	4
Forest	1781.799468	16
Water	8071.981694	72
Grand Total	**11171.25**	**100%**

Table 3: Land use changes in Redang Island in 2000, 2009, 2015, and 2020.

In 2015, there was a reduction in forest land use in Redang Island which recorded a total area of 1006.83 hectares (9%) because it was cleaned for built up activities which caused the use of built up land to increase 790.87 hectares (7%). This has also caused the land use of water has been reduced to 7513.45 hectares (70%).

In 2020. Forest, water, and built up land use has started to increase, recording 1781.80 hectares (16%), 8071.98 hectares (72%), 922.18 hectares (8%) respectively. But in terms of clouds coverage in 2020 there has been a decrease to 395.30 hectares (4%).

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Differences in land use and land cover (LULC) changes from 2000 to 2020

Types of land use	2000		2020		Area changes	
	Area		Area		Area	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Built Up	491.44	4	922.18	8	+430.74	4
Clouds	342.40	3	395.29	4	+52.89	+1
Forest	2038.04	18	1781.80	16	-256.24	1
Water	8184.61	74	8071.98	72	-112.63	2

Table 4: Redang Island land use and total land use changes differences

In terms of differences in land use and land cover (LULC) changes over 20 years in Redang Island is as shown by the type of land use. The type of land use built up in 2000 recorded 491.44 hectares (4%) and increased to 922.18 hectares (8%) in 2020. While for the type of clouds in 2000 was 342.40 hectares (3%) and increased to 395.29 hectares (4%) in 2020. Next, forest land use is 2038.04 hectares (18%) in 2000 and there is a decrease in 2020 which is 1781.80 hectares (16%). And for water land use, it recorded an area of 8184.61 hectares (74%) in 2000 and decreased to 8071.98 hectares (72%) in 2020.

CONCLUSION

In conclusion, land use and land cover (LULC) changes are the main focus in the study area. Land use and land cover around the study area tend to change to the use of saturated land, namely housing. The development of economic development, especially the services sector and the construction of infrastructure networks have greatly influenced the expansion of saturated areas. This study proves that the use of a remote sensing approach and GIS application can facilitate efforts to identify land use changes that occur in an area. Through a systematic mapping system and database, indirect identification of land use changes that occur can help in providing efficient land use planning. The objective of the current study is to analyze Landsat satellite data to identify and map the surface characteristics of the area on Redang Island. All analyzes in this study were conducted using available satellite images. This study uses Landsat 4-5 TM and Landsat 8 OLI / TIRS C1 Level-1 data for the study period 2000, 2009, 2015, and 2020 for the analysis process. The results of the current study clearly show that land use of water areas and forests is still plentiful. This situation is significant with relatively modest urbanization on the East Coast of Redang Island. The results of the analysis that has been done can show that the area of land use study for water always dominates for the selected year's study and in 2020 recorded land use for the water of 8071.98 hectares (72%).

Declaration of Interest Statement
The authors declare no conflict of interest.

Acknowledgments
Not applicable.
Funding
None

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